

Scene Understanding for High Resolution SAR

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Objectives

Resolution	30-10m	10-5m	1m	10cm
Nature objects and scenes	Backscatter amplitude	Backscatter and some textures	Very important use of textures	
Man-made objects	Point of important signal	Some textures and some scatters	Geometrical interpretation using strong scatters	Only a composition of strong scatters
Developed theory	Well-known studies	Knowledge	?	Some research
Missions or used by...	ERS 1/2 RADARSAT		Only experimental airborne data	Military

TerraSAR

Meter resolution SAR analysis



Intermap Maastricht,
0.5m

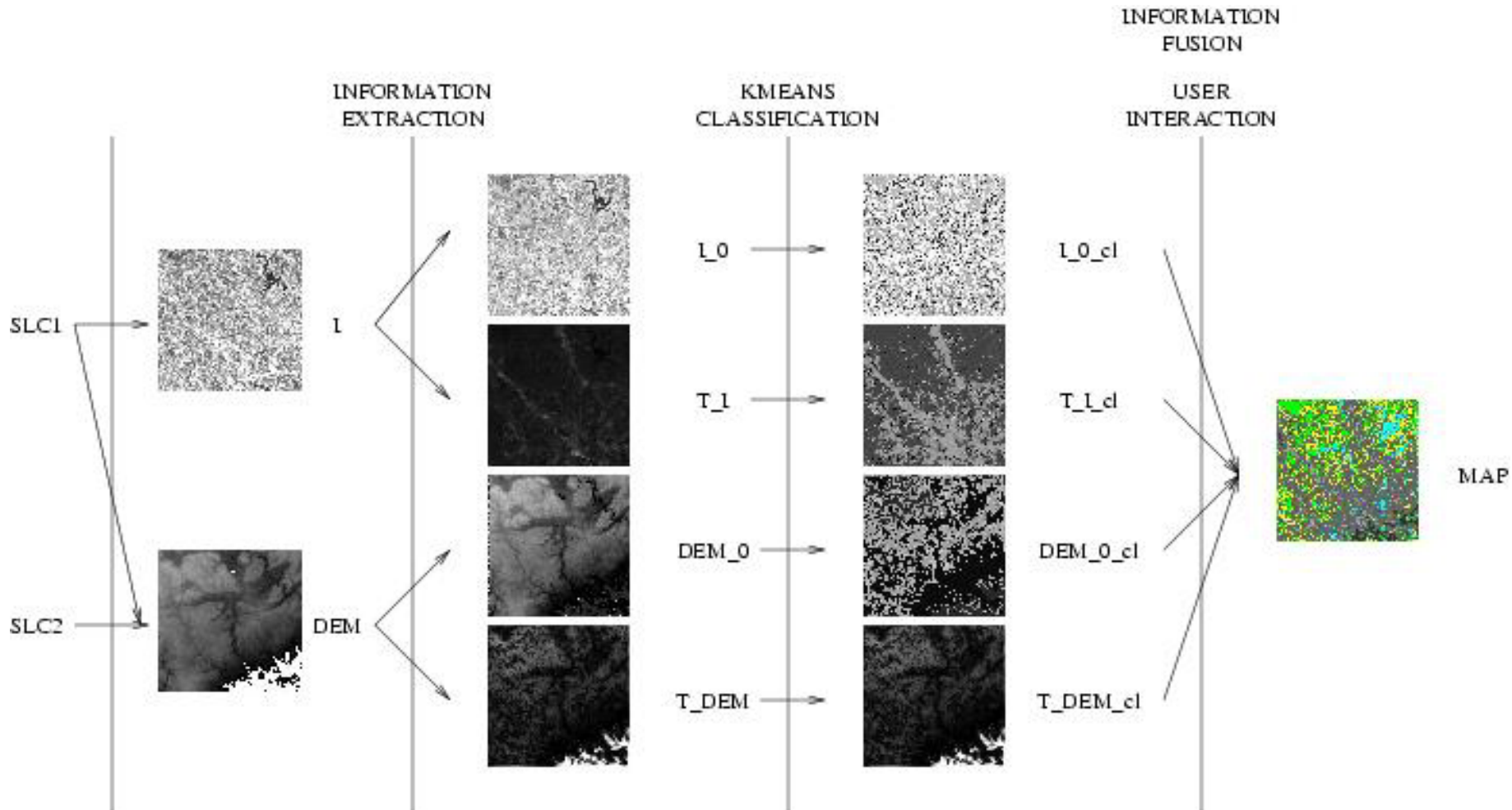
- Target detection
*(adaptive CFAR,
stability over series...)*
- Target characterization
(peak power & phase...)
- Scattering studies
*(scattering models,
simulators...)*
- Target spectral
analysis
*(Wavenumber shift,
range gates...)*
- EM Scattering
(target signatures...)

Complex image
analysis

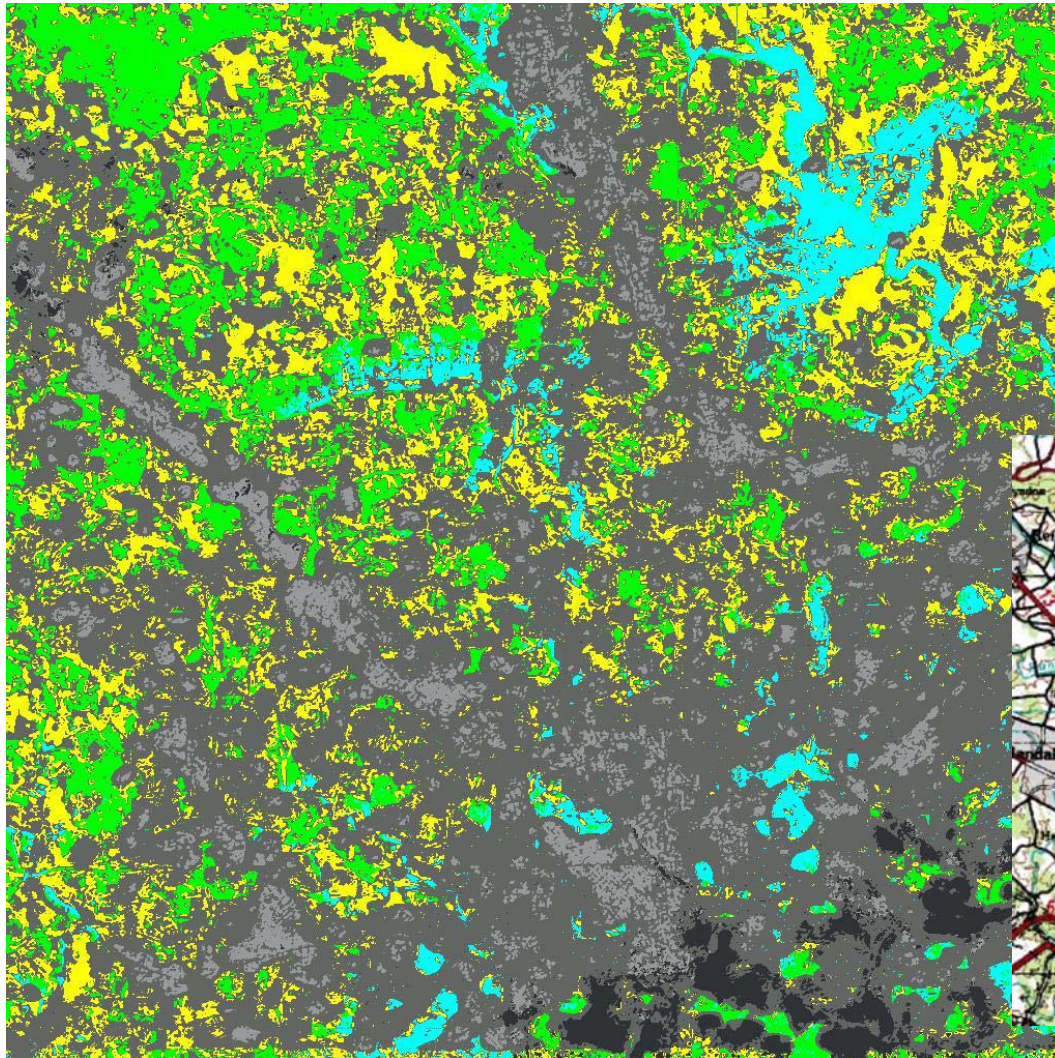
Scene & image
formation
phenomenology







1. **Image Information Mining**
2. **Stochastic Geometrical Modeling and Estimation**
3. **Cepstrum Analysis**
4. **Fourier-Mellin Analysis**
5. **Internal coherence Analysis**

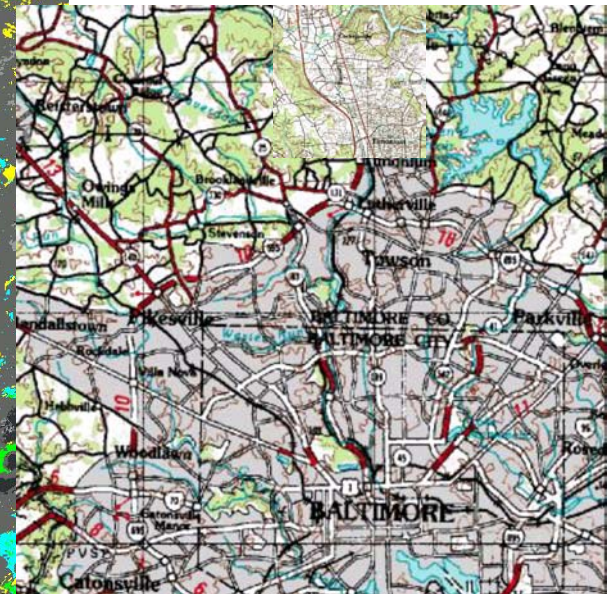
Fusion of features derived from interferogram, intensity, height



2D: Urban Land Use from SRTM data

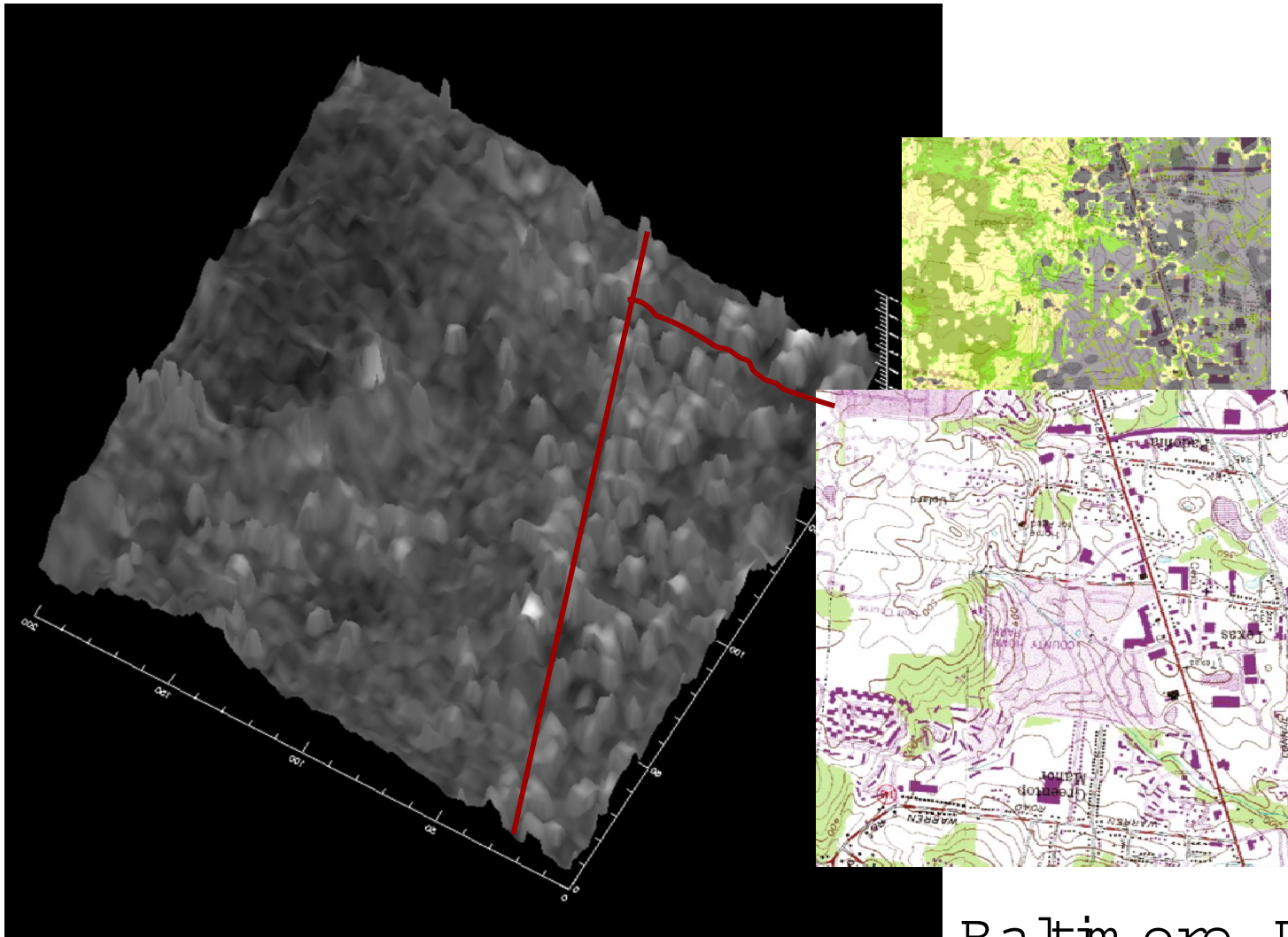


-  dense urbanized
-  medium urbanized
-  light urbanized
-  forest
-  agricultural
-  water



Baltimore, USA

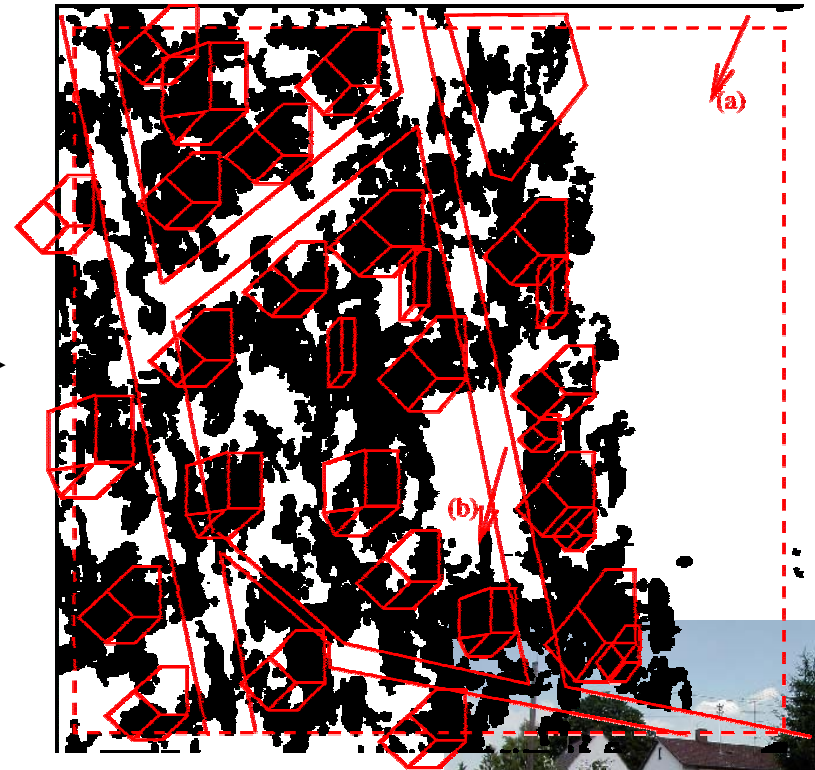
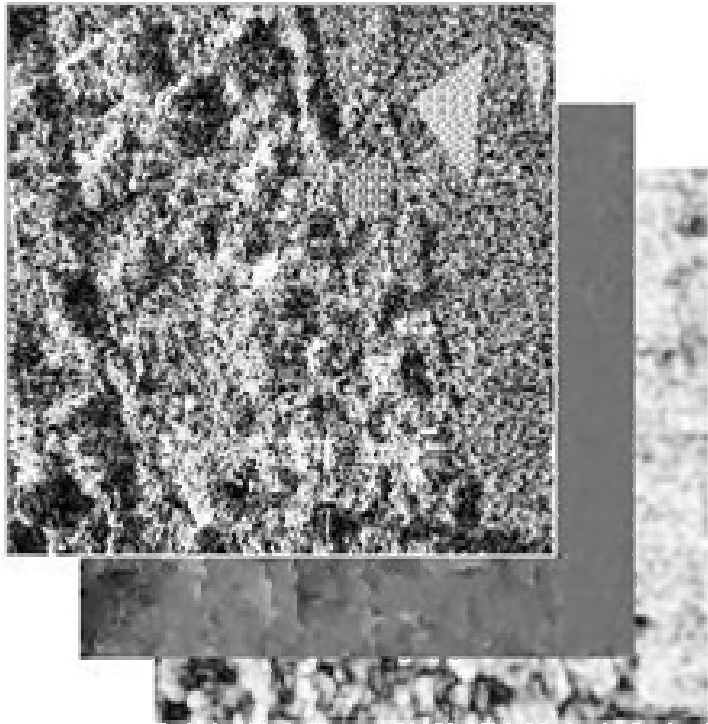
3D: Building detection from SRTM data



Baltimore, USA

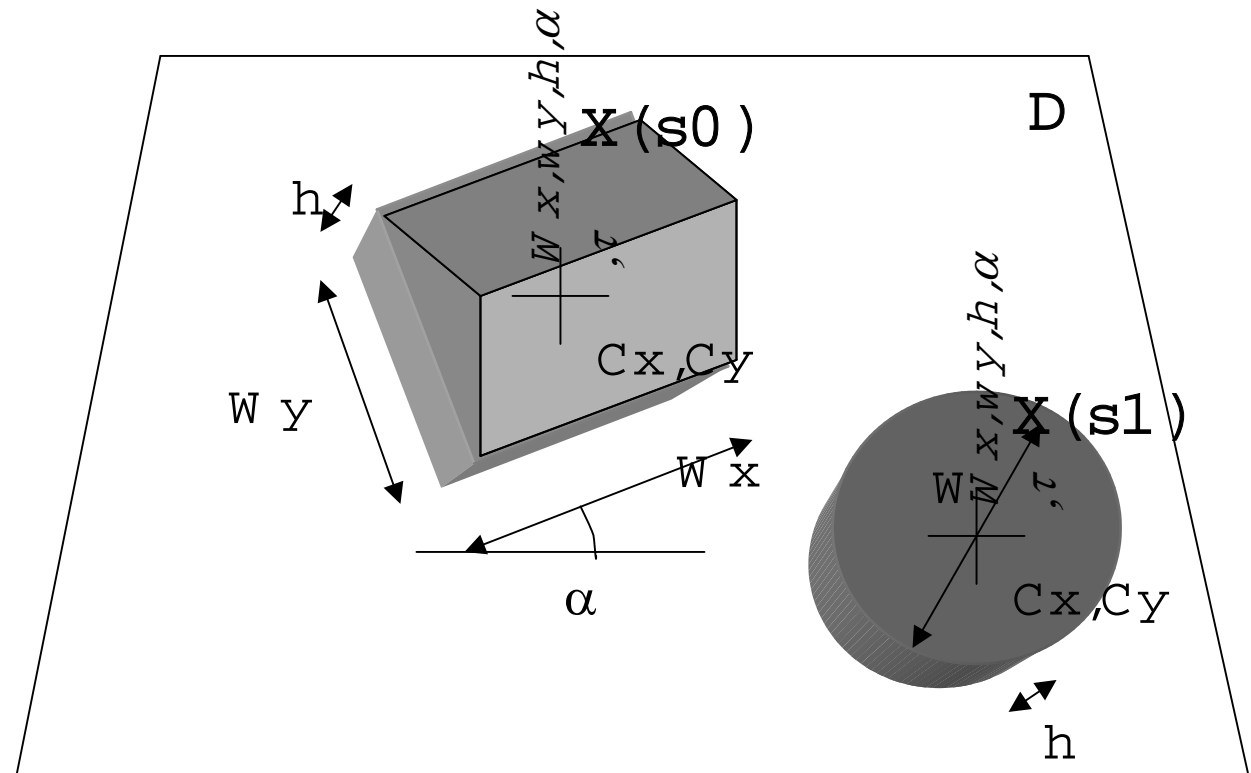
2D: Building detection through information fusion

Intern ap Munich East, 0.5m

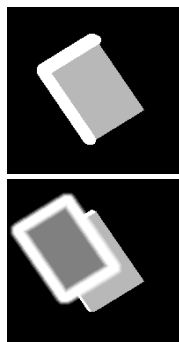
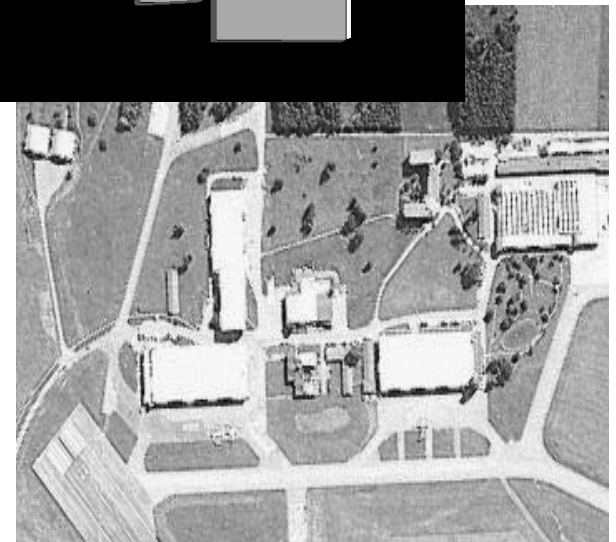
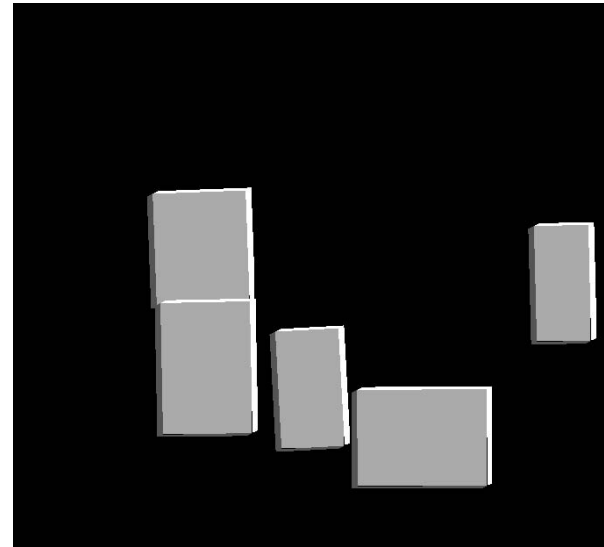
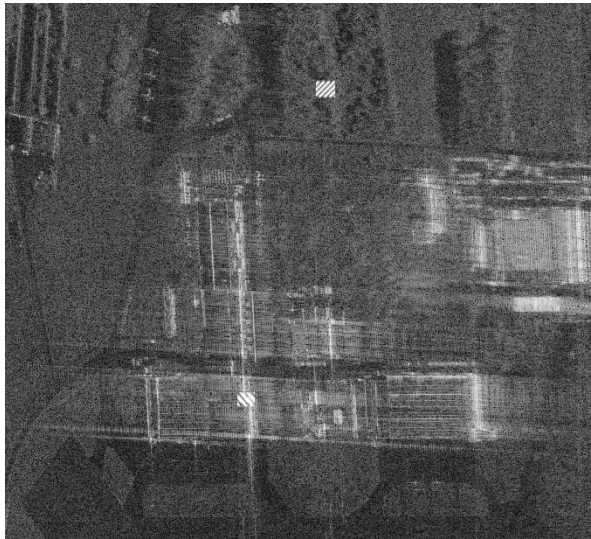


Marked point processes

$$S = \{ X(s) : s \in D \} \quad X(s) = (w, h, \alpha, \tau)$$

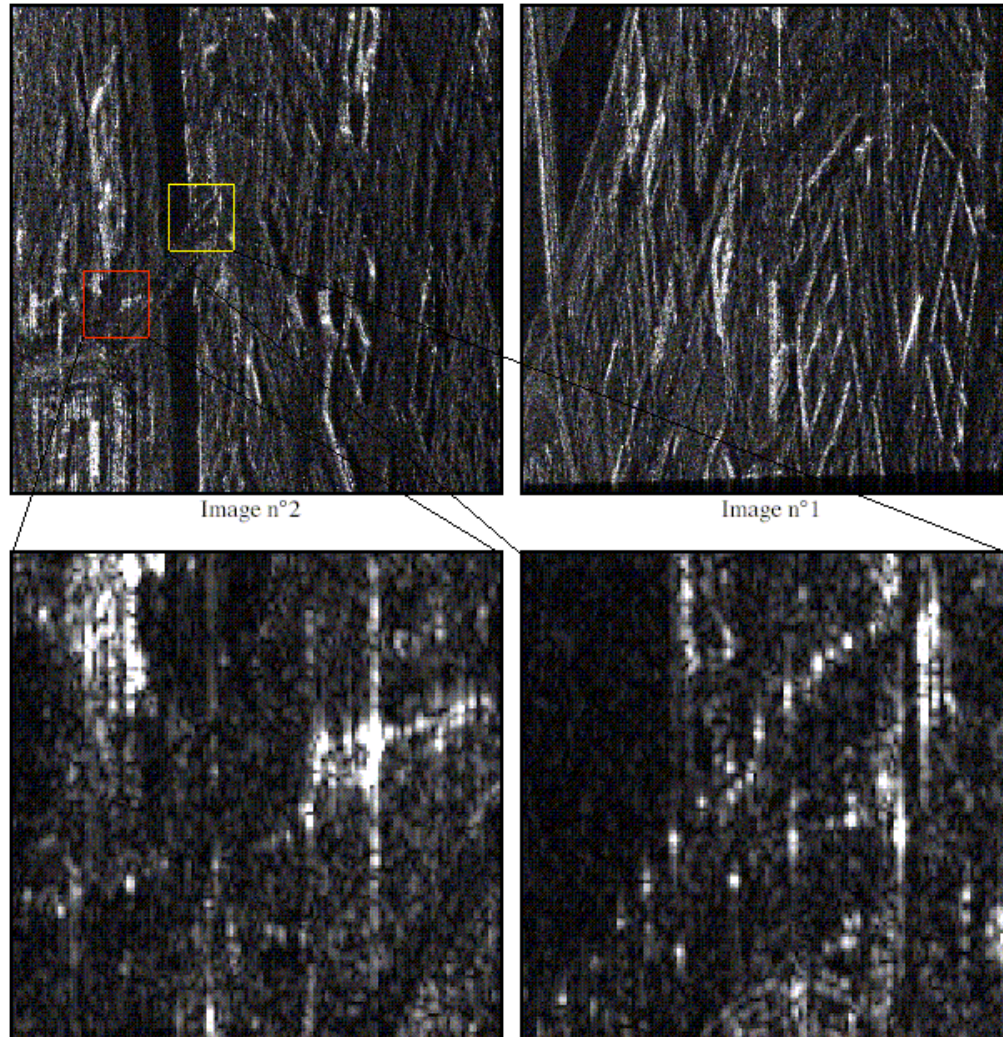


Detection and recognition of industrial buildings

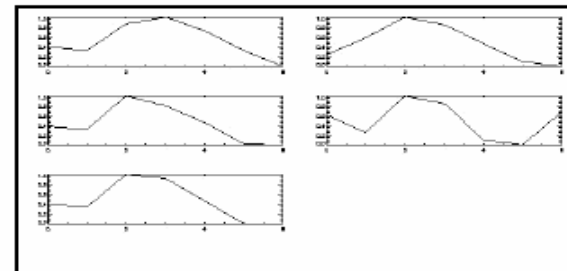
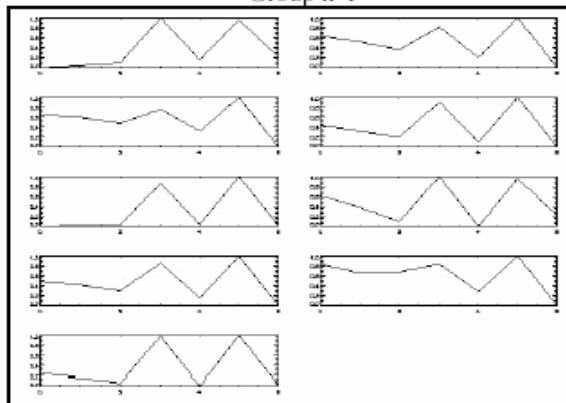
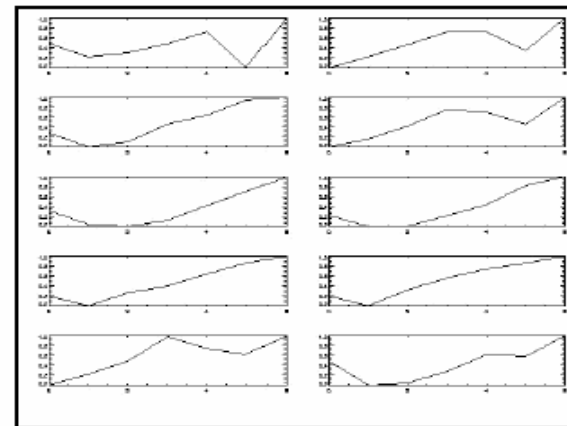
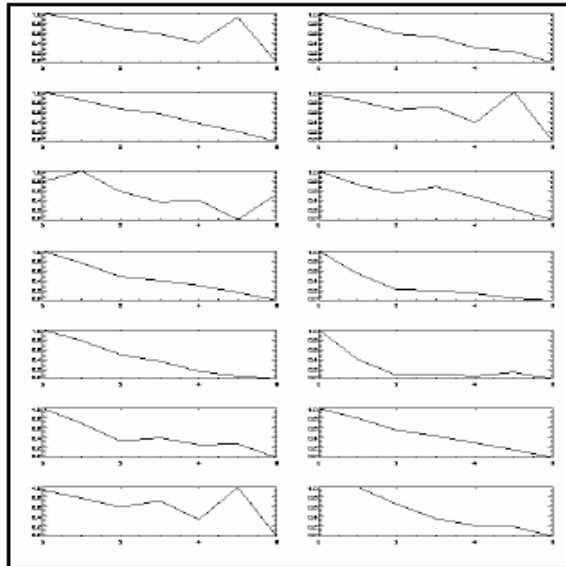


Intern ap Oberpfaffenhofen , 0.5 m

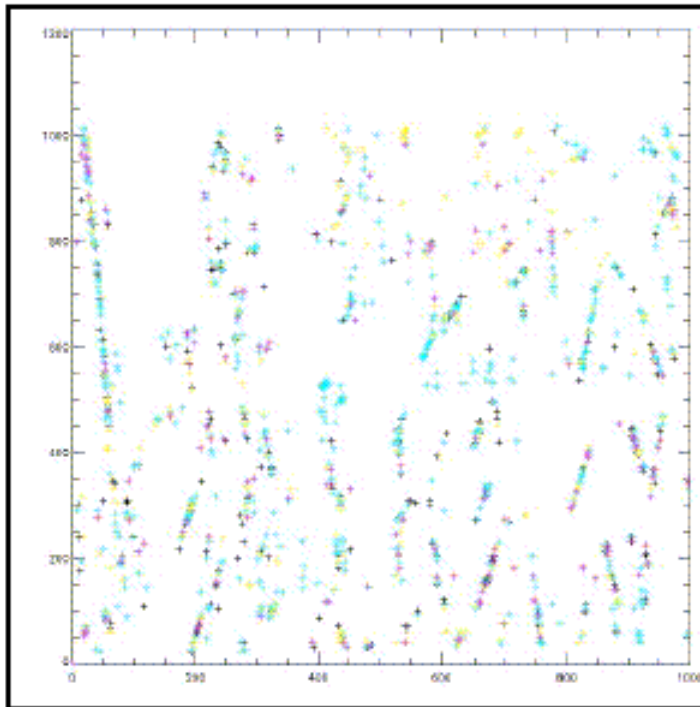
For urban scenes information concentrate in scattering centers



Extract, select and group cepstrum signatures



Targets clasification based on cepstrum signatures



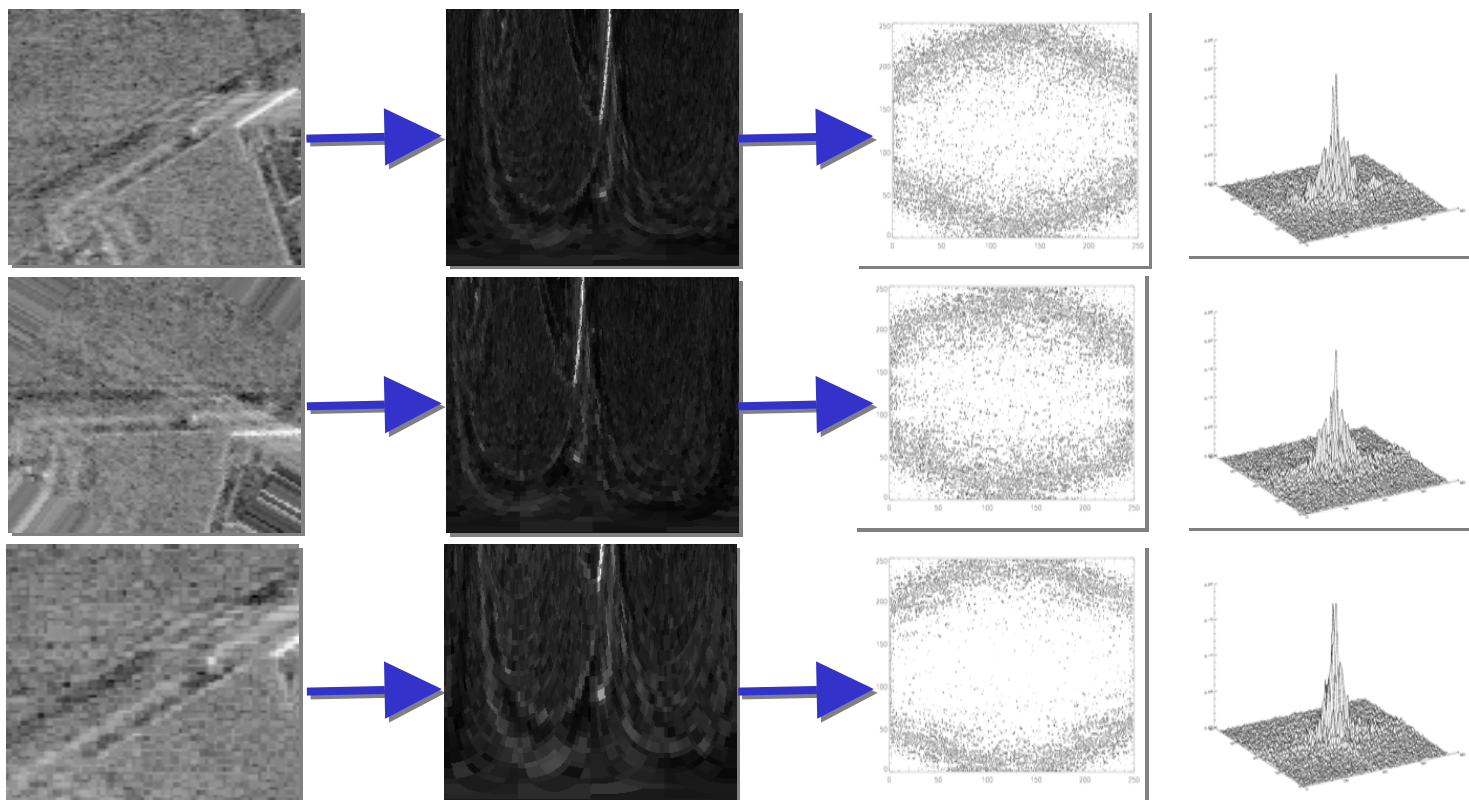
Normalized coefficients grouping for the image n°1; groups are (253, 666, 238, 168)

Observation: good correlation with scene structures

$$\mathcal{M}_{f_{\sigma}}(k, v) = \frac{1}{2\pi} \int_0^{\infty} \int_0^{2\pi} f(r, \theta) r^{\sigma - iv} e^{-ik\theta} d\theta \frac{dr}{r}$$

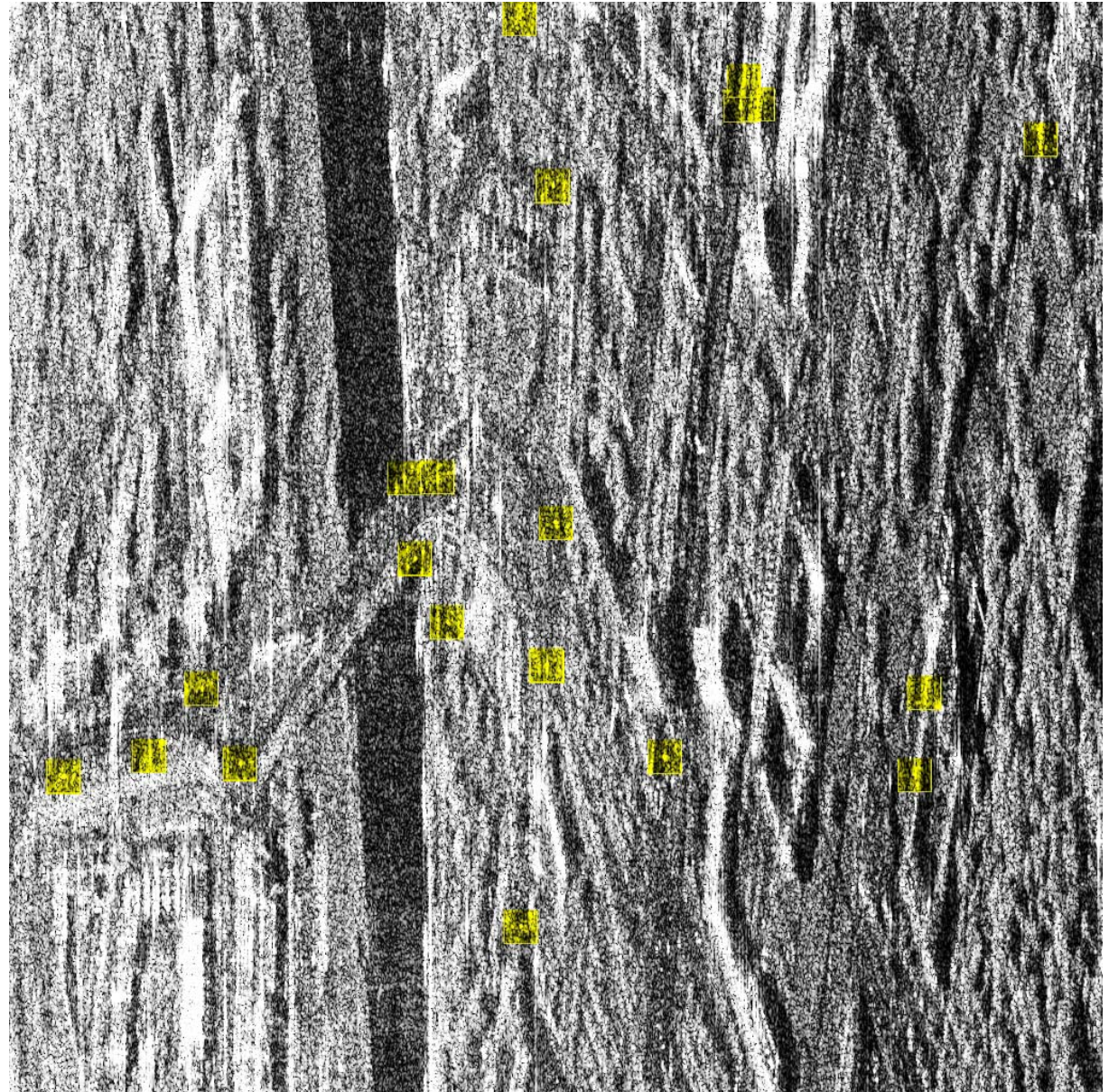
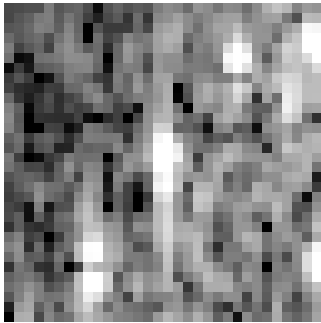
log polar

Fourier Transform



Rotation, scaling invariance

Target detection and recognition Example 1

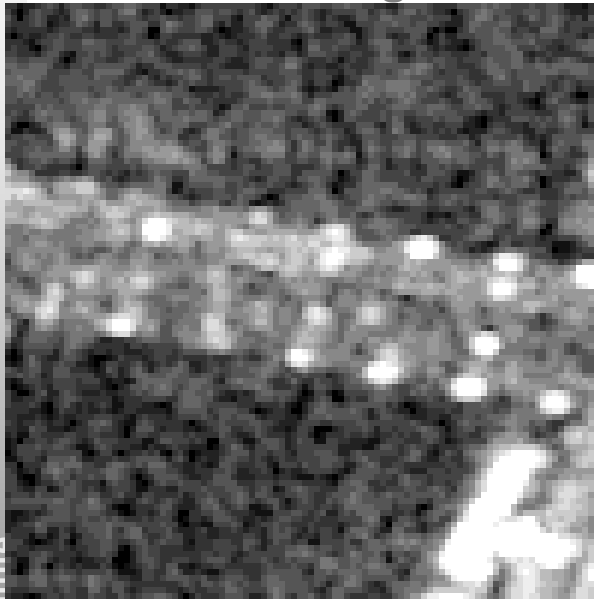


*Dresden,
E-SAR
X band 2m*

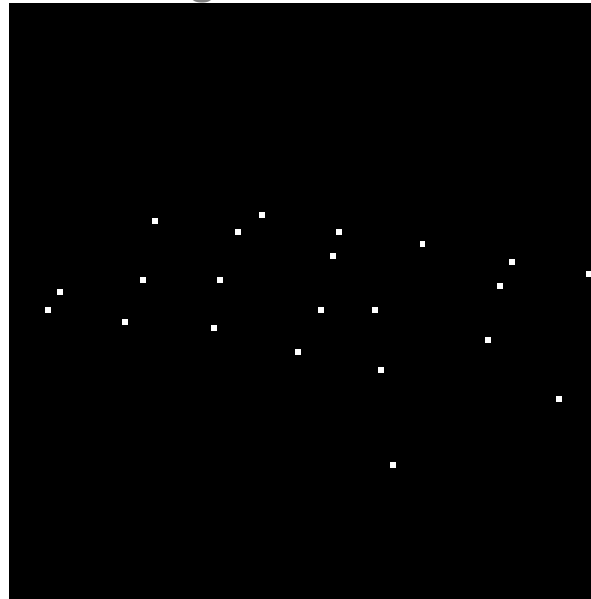
Fourier – Mellin Analysis

Recognition of scene elements: bridge

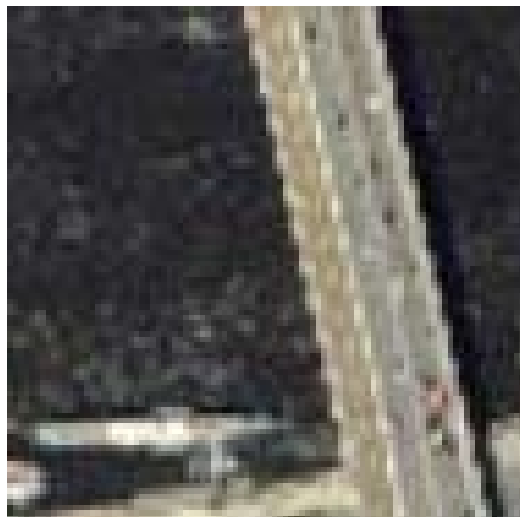
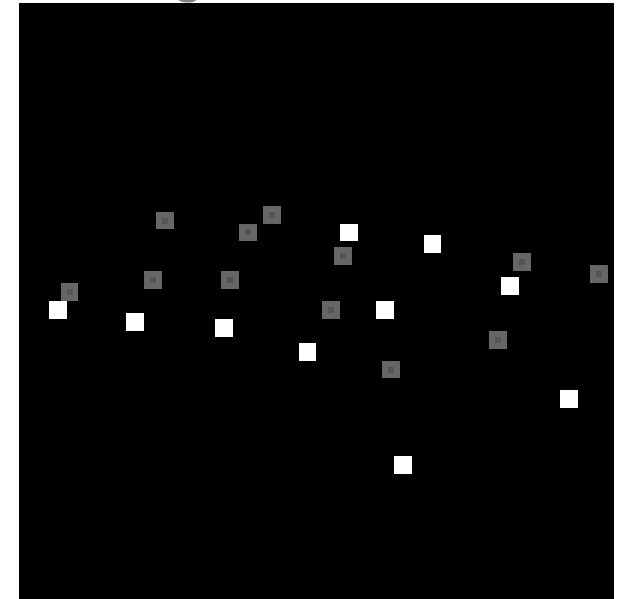
SAR image



Target detection



Target classification



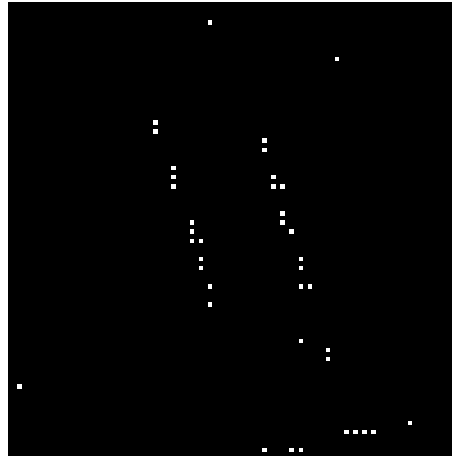
*Dresden,
E-SAR
X band 2m*

Building characterization: base and roof scattering

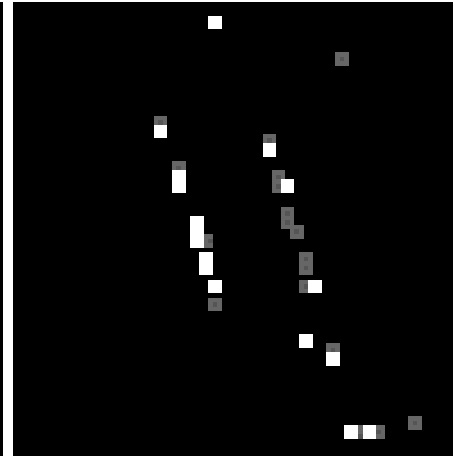
SAR image



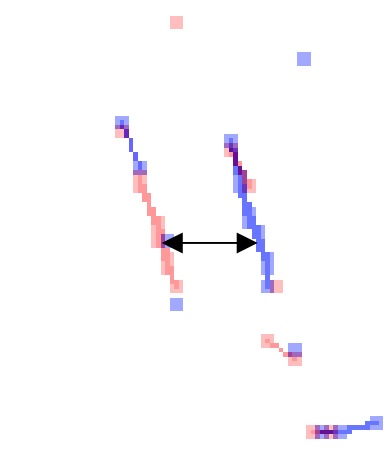
Target detection



Targets classification



Targets grouping



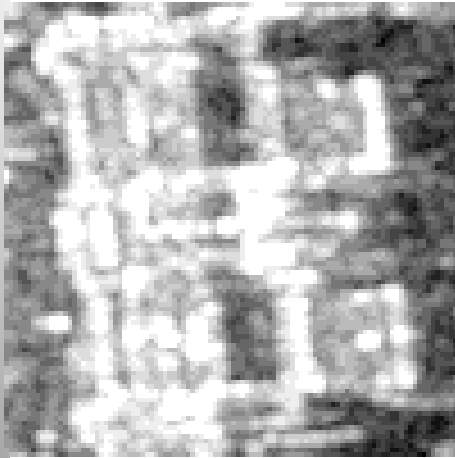
Estimated building height: 14 meters
(consistent with LIDAR)

*Dresden,
E-SAR
X band 2m*



Building elements recognition

SAR image



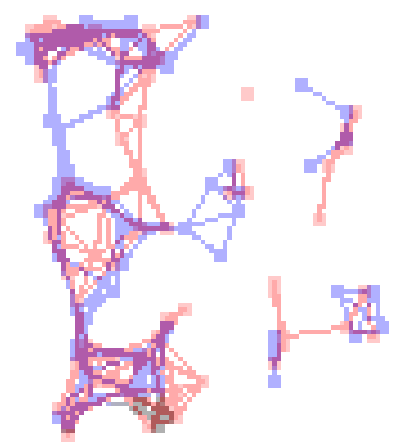
Target detection



Target classification



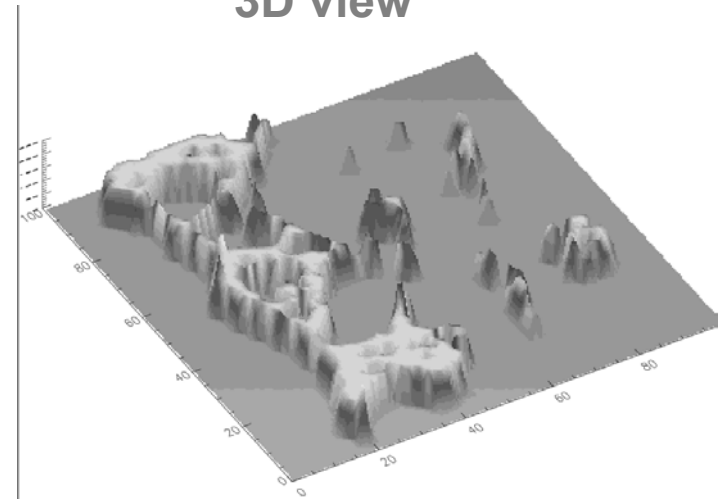
Targets grouping



*Dresden,
E-SAR
X band 2m*

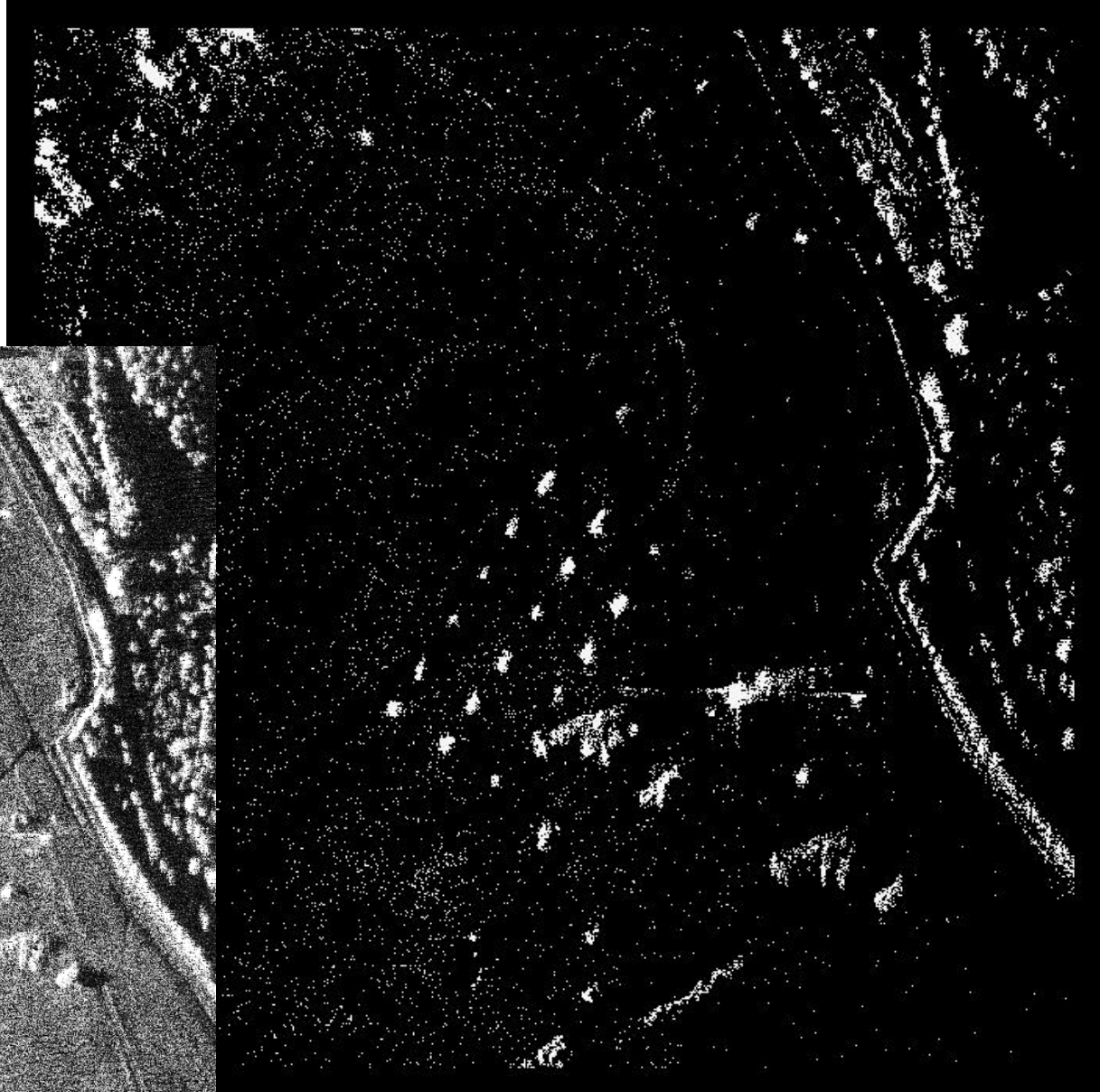


3D view

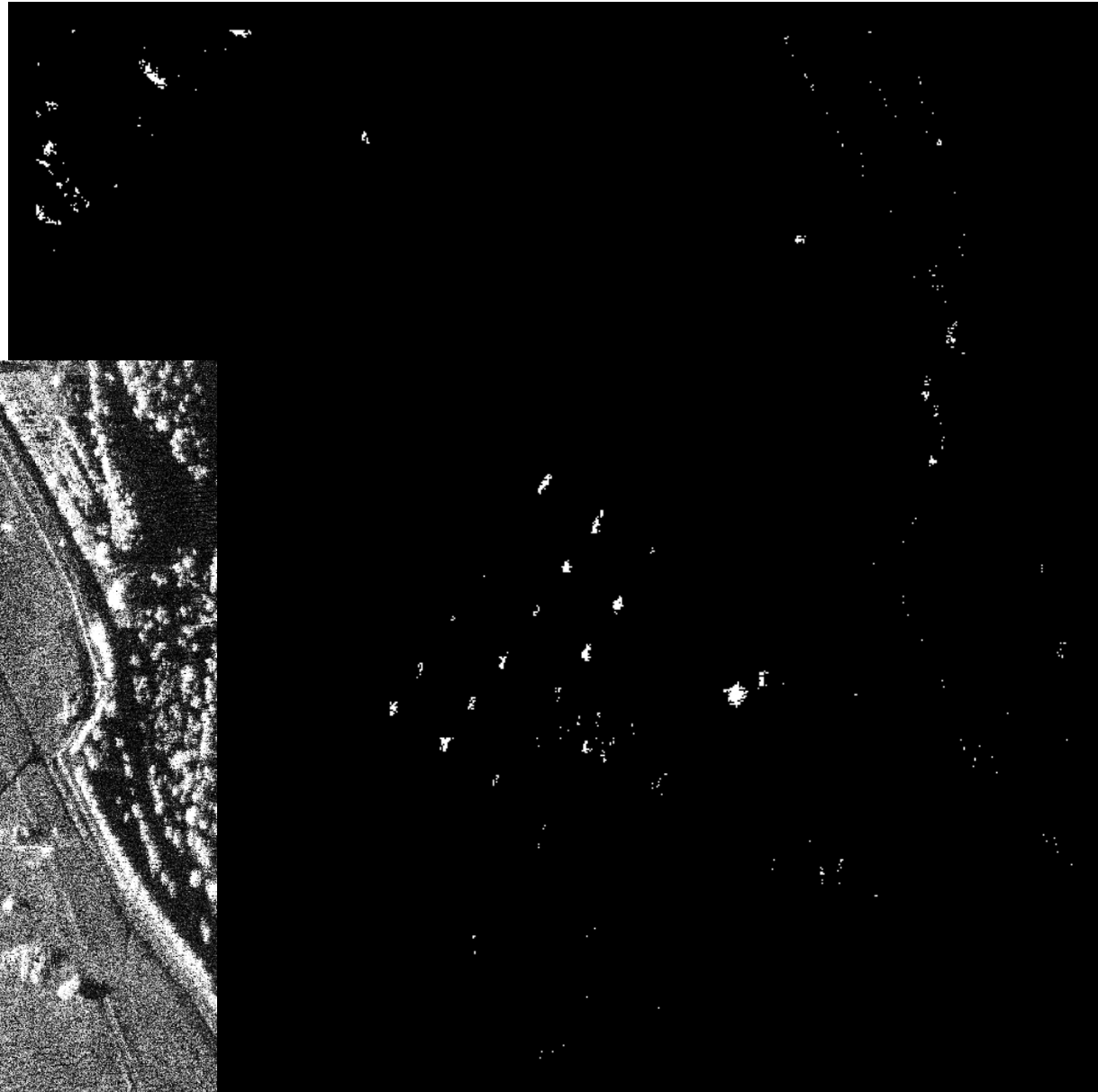


Target detection 1

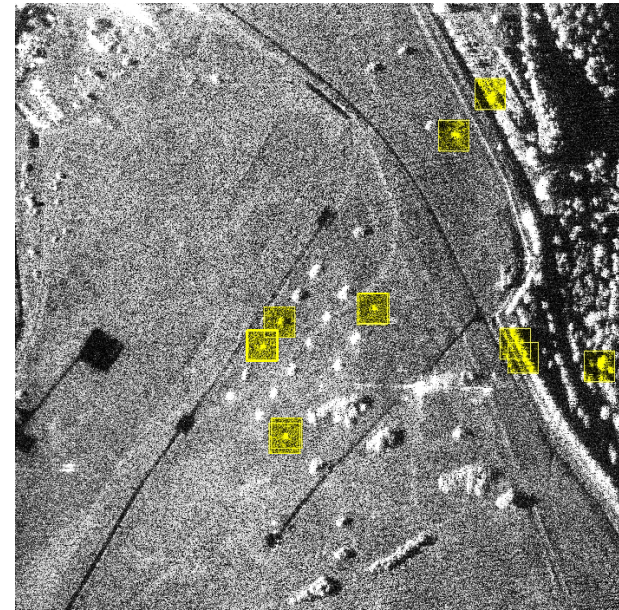
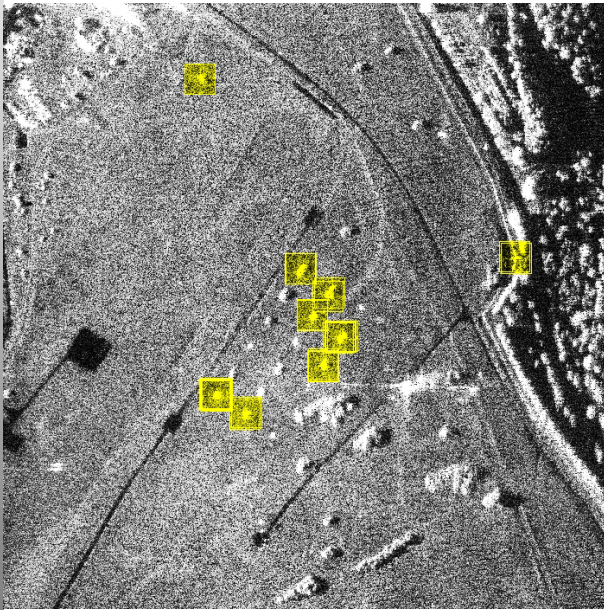
FGAN SAR
HH channel



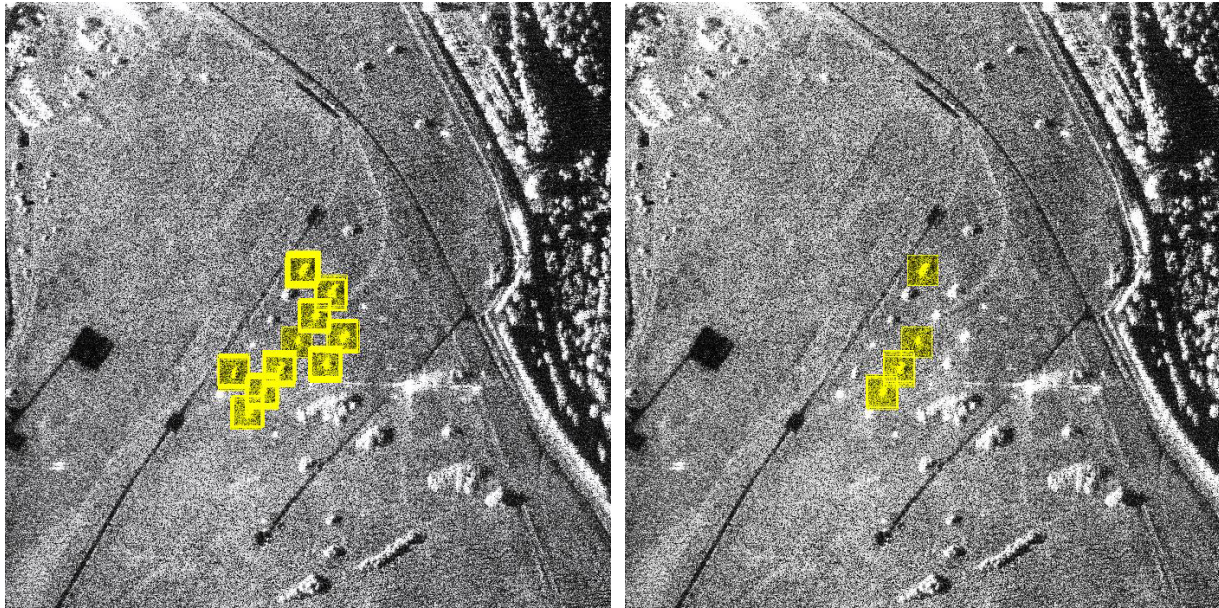
Target detection 2



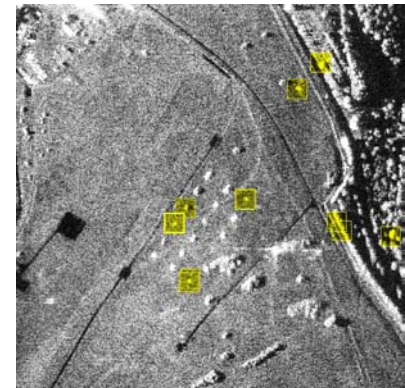
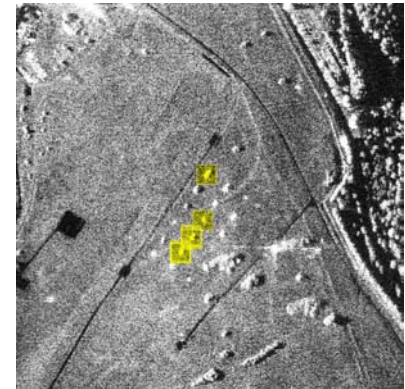
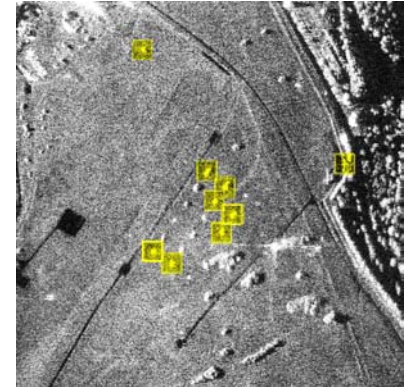
Target classification (HH channel)

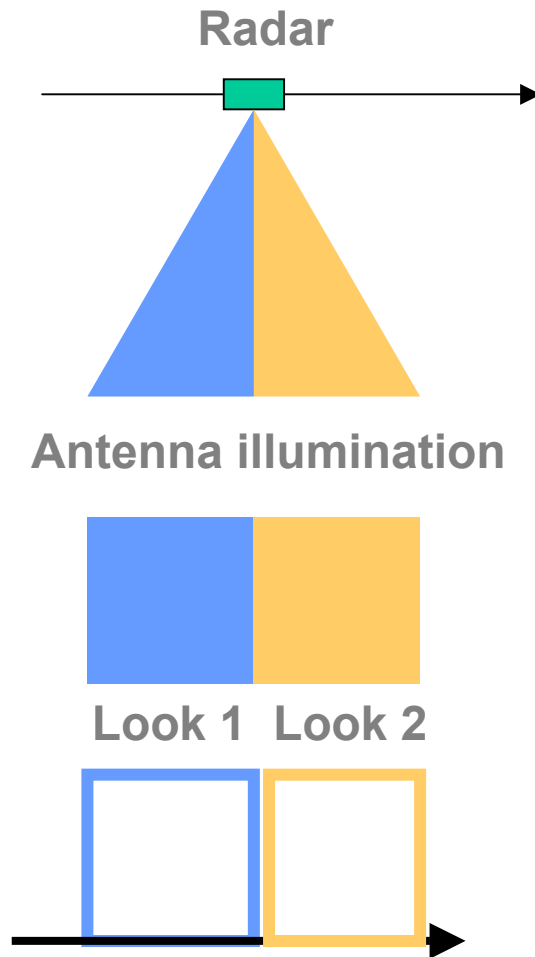


Target classification (PolSAR)



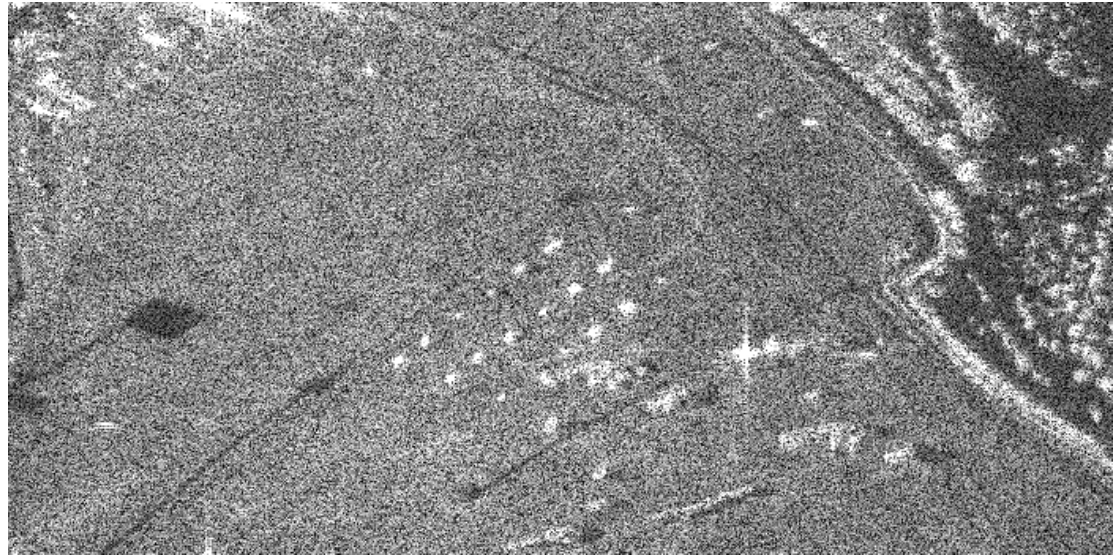
HH channel



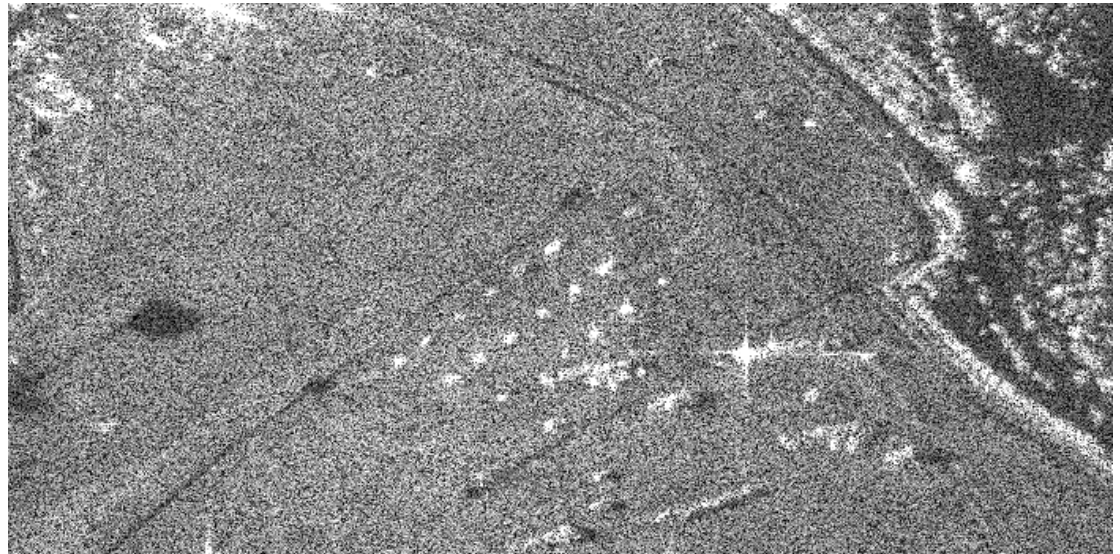


$$\rho_{int} = \frac{\langle s_1 \cdot s_2^* \rangle}{\sqrt{\langle |s_1|^2 \rangle \langle |s_2|^2 \rangle}}$$

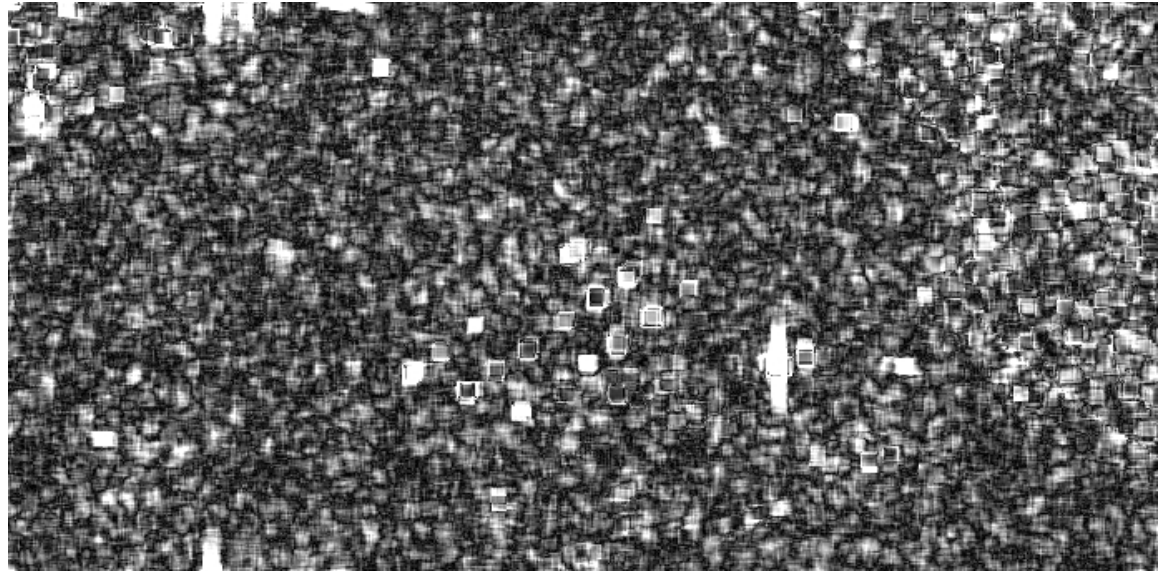
Look 1 (HH channel)



Look 2 (HH channel)



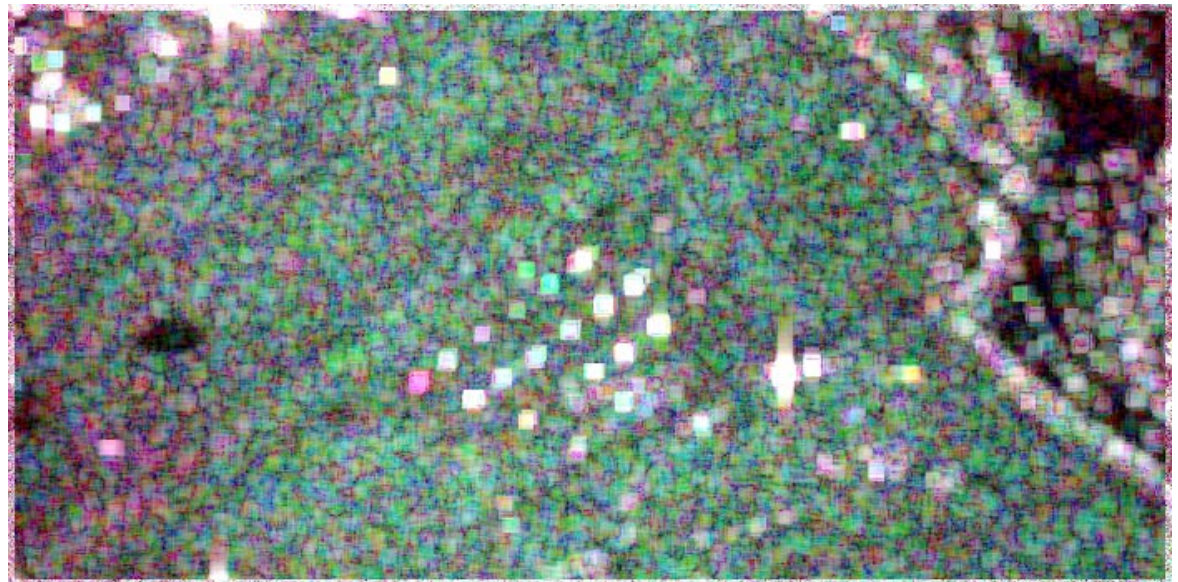
Coherence HH_1*HH_2



Coherence HH_1*HH_2

Coherence HH_1*VV_2

Coherence VV_1*HH_2



Knowledge Driven Image Information Mining **KIM** Knowledge Enabled Services **KES**

On line demo

<http://kes.acsys.it/kimv>

Members: ASI, CNES, CNR, DLR, EC-IST, ESA, ETHZ, EUSC

Chair: Sergio D'Elia, ESA/ESRIN

IIMCG focus: research and technological activities for automated and user centred extraction of information from EO images and image archives in support to content understanding

Events:

ESA-EUSC 2002: Joint seminar on Knowledge driven Information Management in Earth Observation data, ESRIN, Frascati, December 5-6, 2002, Madrid, March 17-18, 2004

ESA-EUSC 2005: Theory and Applications of Knowledge driven Image Information Mining with focus on Earth Observation, ESRIN, Frascati, October, 2005



The screenshot shows the IIMCG website interface. At the top is the ESA logo and a navigation bar with links: Projects, Articles, Documents, Events, Tools, Links, Lexicon, and FAQ. A search bar is also present. The main content area features the IIMCG title and a paragraph stating its creation on May 26, 2003, by its funding members: ASI, CNES, CNR, DLR, EC-IST, ESA, ETHZ, and EUSC. Below this is a large image with the IIMCG logo overlaid. To the right of the image is a sidebar with links: Events, Projects, Documents / Articles / Links, Focus and Mandate, and Contact Points.

Scene Understanding for High Resolution SAR

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Scene Understanding for High Resolution SAR

